Gas-Kinetic Navier-Stokes Solver for Hypersonic Flows in Thermal and Chemical Non-Equilibrium, Phase I

Completed Technology Project (2007 - 2007)

Project Introduction

This SBIR project proposes to develop a gas-kinetic Navier-Stokes solver for simulation of hypersonic flows in thermal and chemical non-equilibrium. The Navier-Stokes solvers adopted in current hypersonic CFD codes like LAURA and GASP use Riemann solver for the convection part and central scheme for the diffusion part. As a result, their integration with DSMC in the transitional and rarefied flow regimes may cause an artificial flow across the interface between CFD/DSMC zones because of the inconsistency in the estimated fluxes. On the other hand, the proposed gas-kinetic BGK solver for the Navier-Stokes equations (BGK-NS) computes the inviscid and viscous fluxes as a single entity, consistent with the DSMC approach. Furthermore, this BGK-NS solver has been demonstrated very accurate for hypersonic heat transfer prediction. The approach has also been successfully extended for solution of the Burnett equations whereas the macroscopic Burnett approach has some numerical difficulties. This SBIR project will further extend this BGK-NS solver to hypersonic flows in thermal and chemical non-equilibrium. In Phase I, a prototype non-equilibrium BGK-NS solver will be developed for the nitrogen shock dissociation cases and then in Phase II, a gas-kinetic CFD counterpart of LAURA will be fully developed and well validated.

Primary U.S. Work Locations and Key Partners
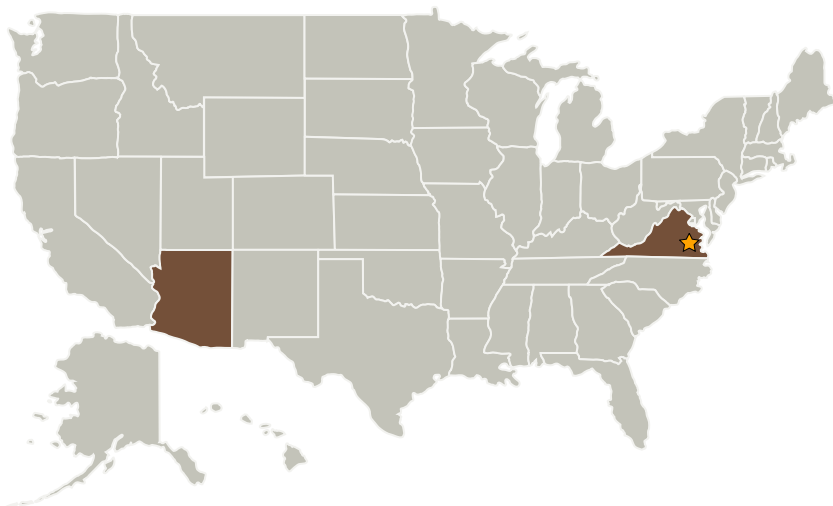
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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Organizations Performing Work	Role	Type	Location
⭐Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
D&P, LLC	Supporting Organization	Industry	Phoenix, Arizona

Primary U.S. Work Locations	
Arizona	Virginia

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  └ TX09.1 Aeroassist and Atmospheric Entry
    └ TX09.1.2 Hypersonic Decelerators